Optimizing Plasmonic Nanoparticle Research with the VSP-G1

introduction

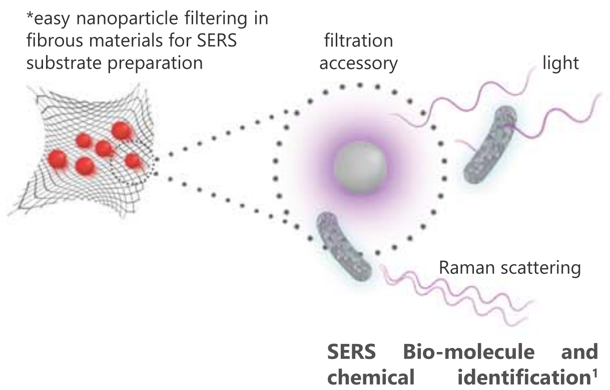
The VSP-G1 produces pure inorganic nanoparticles that are ideal for studying and optimizing nanoparticle properties for plasmonic applications, which are revolutionizing the fields of sensors, optics and energy conversion. Below we illustrate convenient deposition methods (marked *) for particular plasmonic applications (in bold) that exploit particular plasmonic properties (in *italic*). The plasmonic properties can be studied and optimized because of the flexibility of the VSP-G1 and VSPARTICLE tools in tuning the size and composition of the nanoparticles without compromising the extreme purity that the VSP-G1 offers. This flexibility is in great contrast with wet chemistry techniques, which require careful design of complicated chemical recipes in order to change size or composition, compromising purity and the efficient screening of plasmonic properties. The VSP-G1 can screen plasmonic properties without compromising purity at the push of a button.

Plasmonic applications

1 - Field enhancement

Plasmonic nanoparticles can concentrate the incoming light into the nanoscale, allowing the light to interact with (bio)molecules so strongly that the light emission (e.g., Raman) of the molecules is enhanced by orders of magnitude. This allows the identification of molecules/materials even at extremely low concentrations (e.g., single molecule detection). The VSP-G1 allows to maximize the field enhancement without compromising chemical stability by tuning the particle size and composition independently.

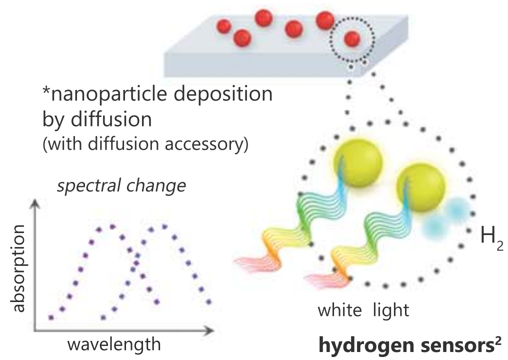
Applications: Surface enhanced Raman spectroscopy (SERS),[1] surface enhanced infrared spectroscopy, biological sensors, shell-isolated nanoparticle-enhanced Raman spectroscopy (SHINERS).



2 - Spectral change

The plasmonic nanoparticle spectra is very sensitive to changes in conductivity of the metal. This way, when metallic nanoparticles interact with hydrogen to form a metal hydride, the conductivity of the material changes and the presence of hydrogen can be then identified by the spectral change.

Applications: hydrogen sensors[2].



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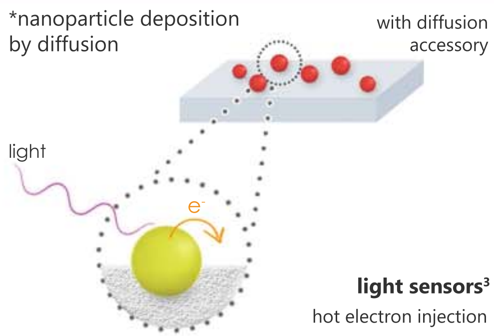
3 - Hot electron injection

Plasmonic nanoparticles can convert the energy of the incident light into hot electrons. Since the light absorption of the plasmonic nanoparticles depend on the size and composition, light sensors sensitive only to light that is absorbed by the nanoparticles can be developed. Hot electrons are also exploited in the field of photo-electrochemistry and solar cells to improve the absorption and quantum efficiency of the materials.

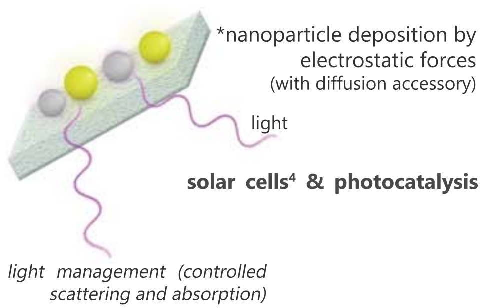
Applications: Light sensors[3], photocatalysis, photo-electrochemistry, solar cells.



4 - Light management

Plasmonic nanoparticles can optimize the absorption of semiconductors by preferentially scattering of light (e.g., antireflecting effect). Moreover, absorption of plasmonic nanoparticles in the infrared (IR) can also be used to warm up windows without compromising transparency of visible light.

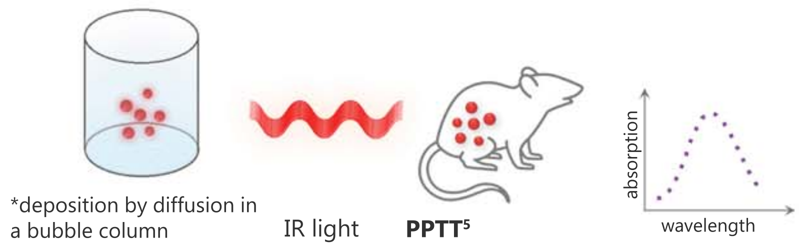
Applications: Solar cells,[4] photocatalysis, photo-electrochemistry.



5 - Plasmonic heating

Plasmonic nanoparticles can be heated up with light, which allows to locally heat up in the nanoscale. Moreover, the tunable spectrum of the plasmonic nanoparticle (i.e., through size and composition), allows to heat up with any light (from UV to IR). This control over the spectrum is used in medical applications like plasmonic photo-thermal treatment (PPTT), where nanoparticles placed in a cancerous tumor can be heated up with IR to treat the tumor, while making sure that the transmission of the chosen light through the biological tissue is maximized in order to avoid harming healthy tissue and monitor the position of the plasmonic particles.

Applications: PPTT[5], Catalysis, electrochemistry, Plasmonic near-field transducer for heat-assisted magnetic recording.



References

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